Yield Management for Online Web Service Providers
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With the advent of the Internet, the worldwide web (www) has become a ubiquitous platform for enterprises and consumers to interact, learn, network and transact business. It continues to provide a new channel between providers and customers and promises to enable business models to run on cheaper operational and financial expenses rather than old brick and mortar models that require capital investments in buildings, warehouses, stores and human capital. The services sector in particular has struck it big with www. The platform of www has spread its utility across many industries, ranging from retail, financial, healthcare, education, communications and entertainment. In particular, let's consider the online IT services industry for the focus of this blog.

As Web 2.0 gains ground, the adoption of Software-as-a-Service (SaaS) appears inevitable. Gartner reports that by 2013, 40 percent of e-commerce deployments will use complete SaaS e-commerce solutions, and 90 percent of e-commerce sites will subscribe to at least one SaaS-based service, such as product reviews, product recommendations, or social sales capabilities.

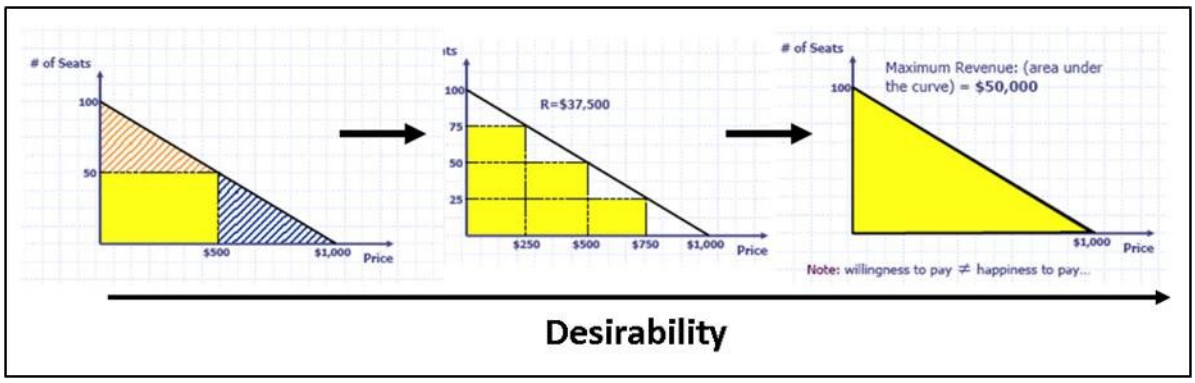
SaaS programs exist in a web-based format and allow users to essentially rent an application for a monthly or annual charge. For instance, instead of purchasing an accounting system, installing it on servers, and maintaining and updating it, a business can instead use the program over its high-speed connection hosted on a remote third-party location. The programs run either through a secure web browser or custom interface, providing the user with anywhere / anytime access to a comparable full-strength program. SaaS and hosted programs have been around a decade, but only in the recent years have they really matured into fully-featured solutions that people can rely on for their computing needs, small business owners can rely on to run their businesses, and professionals can rely on to provide accurate and dependable client service.

The SaaS concept led to the evolution of electronic cloud computing. One definition of cloud computing by academia at the University of California, Berkeley is "both the applications delivered as services over the internet (SaaS), and the hardware and systems software in the datacenters that provide those services". Instead of users simply having subscription-based access to programs (SaaS), organizations, corporations and other entities can also buy access to virtual machines, storage space and even datacenters, allowing them to rapidly expand their own IT capabilities in very little time, but without the infrastructure and maintenance investment.

So, to put it simply, cloud computing offers rental of 'virtual space' for businesses to host and run their IT infrastructure. Although the model is getting popular among businesses, especially small to medium businesses, it is still in very germinal stages. Before it can be pitched as a perfect product, it has to overcome many issues around online security and data privacy, among others. While substantial investments are being made in making the model more robust and in marketing the current model, perhaps the cloud computing service providers may be overlooking a very simple technique to increase their revenue from their current models. If the earlier reference to the term 'rental' drew your attention momentarily to car rentals, then you're not digressing at all. As a matter of fact, we'll see how yield management (YM), a revenue optimizing technique, can be used by the web service providers, offering cloud computing services, to maximize their own revenue.

Yield management is the practice of maximizing profits from the sale of perishable assets by controlling the price and inventory. In other words, it allows the capture of a larger portion of the available revenue by sensing the price elasticity of different customer segments and manipulating prices accordingly.

Figure 1



Pioneers and successful adopters from the airline, hotel, tourism, and car rental industries have witnessed significant revenue increases. Let's take a simplistic view of how yield management works and then draw a parallel to how it may work for web service providers.

Key relevant concepts of yield management in the airline industry:

- Consumer Behavior: The consumer segment is generally composed of the leisure traveler and business traveler. The distinction between these segments is that the leisure traveler books ahead of time to find cheaper tickets while a business traveler only shows demand near the last few days or hours of travel. Business logic suggests that the latter be charged a premium due to the inelastic nature of his demand, but in order to do so, the trade-off would be to reserve some seats ahead of time at the risk of having them unsold at the time of consumption.
- Booking Limit: The booking limit in this scenario is the maximum number of rooms that may be sold at a discount price. Assume that leisure customers arrive before business customers, so the booking limit constrains the number of rooms that these customers get. Once the booking limit is reached, all future customers will be offered the full price.
- Protection Limit: The protection limit is the number of rooms that will not be sold to leisure customers because of the possibility that business customers might book later.
- Business characteristics exploited for effective yield management:
    - Capital intensive and limited fixed capacity
    - When the resource / product / inventory is perishable and is wasted if not used at a particular time
    - When the product / inventory is identical or at least very similar, but can be catered to and used very differently by different customer segments
    - Well-defined segmentation of 'leisure' vs. 'business / premium' customer who is willing to pay a higher price for the inventory if purchased very close to the time of consumption. This is not to be confused with price discrimination, as the higher price is put in place not forcefully but because there is a market ready to pay such prices.

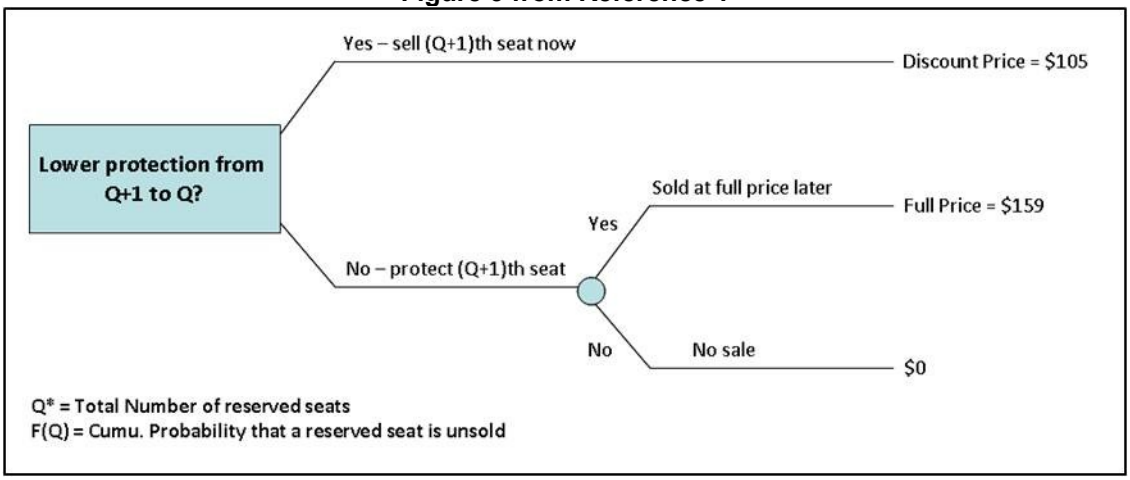
Case: Say an airline carrier has 210 seats. The Discount Price is $105 and Full fare is $159. To simplify the scenario, assume there is just one service class. Below is the demand forecast provided by the operations / business intelligence team for this season:

Figure 2 from Reference 1

Demand for Seats at full fare (Q)	# Days with Demand	Cumulative Probability F(Q) i.e. Prob{D<=Q}
0-70	12	0.098
71	3	0.122
72	3	0.146
73	2	0.163
74	0	0.163
75	4	0.195
76	5	0.228
77	5	0.268
78	2	0.285
79	7	0.341
80	4	0.374
81	10	0.455
82	13	0.561
83	12	0.659
84	4	0.691
85	9	0.764
86	10	0.846
Above 86	19	1
TOTAL	123	1

How will you optimize for the right number of reservations? Assume your historical average for the seats sold is around 70. Now, as you keep increasing the number of reserved seats, the probability that the incremental seat might not be sold also keeps increasing. Thus, as Q* increases, F(Q) also increases. Conversely, the probability that the incremental seat might get sold (1-F(Q)) reduces. The business problem can be depicted as:

Figure 3 from Reference 1



To compute the optimum protection limit:

Start with the maximum of the range available for reservation (as determined by demand forecast), in this case 87. Reduce the protection limit by 1. If the expected revenue generated by protecting a seat is less than the expected revenue by not protecting the seat, then it is better to not reserve. i.e.

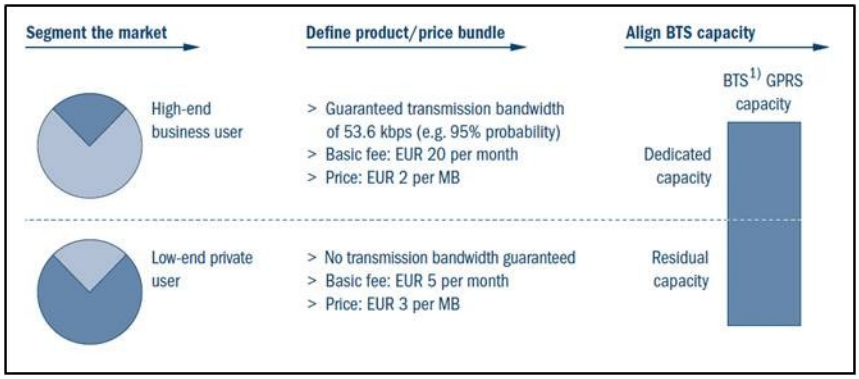
$$E[\mathrm{Rev}(\mathrm{Protect\,Seat})] \le E[\mathrm{Rev}(\mathrm{Not\,Protect})]$$
$$\Rightarrow [1 - F(Q)] * \$159 + F(Q) * \$0 \le \$105$$
$$\Rightarrow F(Q) \le 0.339$$

From the forecast table (Figure 2) that value would be 0.341, i.e. 79 seats. Thus, 79 seats may be reserved for the business class. Any further reservation will increase the probability of the seat not being sold and the loss of expected revenue. An additional concept of 'overbooking' is also used by many to account for no-shows / cancellations. The logic used in doing so is similar to the one described above, in which you compare the expected revenue of overbooking an additional seat with that of not overbooking.

All of the above are very simplistic scenarios. Yield management systems are often highly customized to specific industries as they account for varying business policies, customer segments / behavior, etc.

Recent adopters of yield management are within the high tech industry. Take the case of telecommunications. Investments in capacity are intensive, capacity is limited and the product (data transmission speed / bandwidth) is perishable. The telecomm industry has been exploiting the marketshare per customer and their price elasticity to develop enhanced offerings around type of transmission (always on / dialup), access priorities (waiting time when capacity is in demand / priority access), office solutions (calendaring, e-mail, directory SAP access), location-based services, m-commerce, and news functions (MMS, video conferencing), to name just a few, so as to cater to the different customer segments of individual consumers to corporate accounts.

Figure 4 from Reference 3



Project analyses by Roland Berger Strategy Consultants have found a 3-8% increase in revenue for yield management adopters in the telecomm industry.

Other industries jumping on the yield management bandwagon are Internet service providers (ISPs) and media advertising (mass media). There is no reason why web service providers offering online advertisements and cloud computing services like Google, Yahoo, Microsoft, and Amazon.com cannot use this technique effectively. Online advertisement inventory and virtual storage / infrastructure if unused at any time will perish. Well-defined customer segments exist who are willing to pay a premium if serviced in real-time or with additional features. Yield management in this case can be used to set advertisement slots or virtual space allocations (server use, storage and bandwidth) at multiple price points to different customer segments depending on resource availability and market demand.

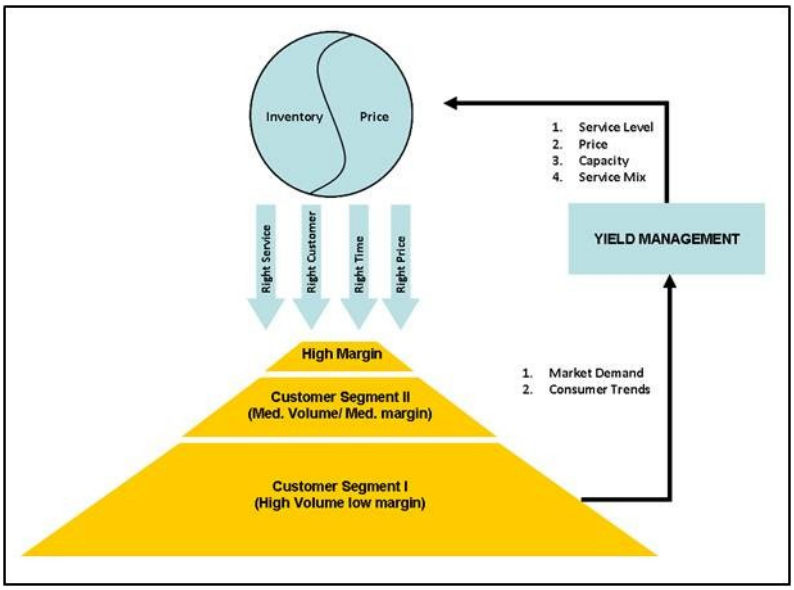
There are however, substantial differences for ISPs and telecomm when compared with traditional businesses using yield management. An airline seat is occupied for the fixed duration of the flight, and the number of seats available is known in advance. An on-demand web service job, on the other hand, depends upon the type of servers, number of servers, and combination of servers (i.e. both capacity and duration of the job cannot be pre-determined and have to be discovered in real-time).

To an extent, time variability also features in the hotel and golf course industries, but the capacity in question is still fixed for them. The telecomm & internet service providers have been researching and creating algorithms based on mathematical models of queuing theory to account for better resource usage. However, the success of this technique has not been very clearly documented. Even if the issue of variable capacity usage is addressed, another vital difference between the telecomm / ISPs and web service vendors, real-time on-demand, would still pose a challenge.

IBM Research Center has been working on developing a framework that considers the real-time on-demand factor. In the framework they have integrated components such as:

- Demand Change Detector
- Customer Behavior Detector
- Yield Management Engine
- Price & Service Level Offering Engine
- The framework can be interpreted as depicted below:

Figure 5



Refer to the article A Real-Time Yield Management Framework for E-Services (Reference 4) for the detailed numerical models. The gist is that the two essential differences between traditional businesses using yield management and web service providers are real-time on-demand and variable capacity usage. These issues can be theoretically accommodated using the 'yield management engine' to enhance the fundamental concept of yield management and achieve revenue optimization.

The online web services industry is very dynamic and exponentially evolving. It is unlikely that any standard yield management software will end up gaining a large market share. It does, however, present an opportunity for software vendors to build high-margin customized IT solutions and for business process consultants to cater improved operational / financial processes to strengthen the web service industry's top line.

References:

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